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ABSTRACT

The effectiveness of problem-based learning (PBL) in preparing for the Medical College Admission Test (MCAT) was studied. A 10-week PBL experience was implemented to supplement lecture-based instruction in preparing for the MCAT. Over 2 years, 33 students participated. Participants met for 3 hours in small PBL groups directed by a tutor three times weekly to solve timed MCAT passages. After two summers of incorporating PBL into the program, the mean MCAT composite score increased by 2.6 (14%) points. Nineteen of the 33 participants increased their MCAT score by at least 3 points. And 25 (76%) believed that the PBL methodology helped them prepare for the MCAT. (SLD)

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INCORPORATING PROBLEM-BASED LEARNING METHODOLOGY TO PREPARE FOR THE MEDICAL COLLEGE ADMISSION TEST

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A paper presentation to the Annual Meeting of the American Education Research Association, Seattle, Washington, April 13, 2001

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ABSTRACT

Introduction: We implemented a 10-week problem-based learning (PBL) experience to supplement lecture-based instruction to prepare for the Medical College Admission Test (MCAT).
Methodology: Participants met for three hours in small PBL groups directed by a tutor, three times weekly to solve timed MCAT passages.
Results: After two summers incorporating PBL in the program, the mean MCAT composite score increased by 2.6 (14%) points. Nineteen (58%) of the 33 participants increased their MCAT composite score by at least 3 point. Twenty-five (76%) believed that the PBL methodology helped them prepare for the MCAT.
Conclusions: Results from implementing the PBL methodology during the summer of 1999 and 2000 enhanced the academic performance of participants on the MCAT. Participants perceived PBL as a beneficial process to prepare for the MCAT. Sustained improvements in cognitive outcomes are needed to evaluate the effectiveness of incorporating PBL in the MCAT preparation experience.

INTRODUCTION

Indiana University School of Medicine (IUSM) operates a Medical College Admission Test (MCAT) Preparation Program to prepare students from underrepresented minority (URM) and disadvantaged backgrounds to become more successful candidates for admission. The program helps IUSM to achieve diversity of its student body and promotes the training of physicians for medically under-served communities. The program focuses on unsuccessful medical school applicants who have the potential for careers as physicians. Students who are selected for the program take an intensive 10-week summer program, designed to help them improve their MCAT scores.

The MCAT evaluates mastery of basic concepts in Biology, Chemistry, and Physics, proficiency in scientific problem solving and critical thinking, and writing skills. [1] Passage-based sections of the test include Verbal Reasoning, Physical Sciences, Writing Sample, and Biological Sciences. Verbal Reasoning, Physical Sciences, and biological Sciences sections of the MCAT contain multiple-choice questions and most of these questions accompany brief informational passages. A smaller number of questions are independent of any passage and of each other.

Some students from URM and disadvantaged backgrounds experience disproportionate difficulty with these tests. We have been attempting to address part of this problem through the MCAT Preparation Program, in which most of the students are required to increase their MCAT scores in order to gain admission to medical school. Since the program's inception in 1995, approximately half of its participants achieve significant improvement in their MCAT scores each year. For the program to achieve its goals, this fraction needs to be increased. A composite increase in a

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student's MCAT score of at least 3 points is considered significant.

GOALS

The goals of this research project are the following: (1) Incorporate a PBL approach to help students develop reasoning skills necessary to enhance their performance on the MCAT. (2) Reinforce the following competency goals of IUSM's curriculum: promote effective communication as well as enhance lifelong learning, problem solving, and science knowledge base.

IMPORTANCE OF THE STUDY

Motivation to tackle the MCAT another time is a major problem for some of the students in the summer program. Each year, approximately half of the students who retake the MCAT fail to significantly change their scores. Since enhanced self-esteem and increased motivation for learning are natural outcomes when students assert control over the learning process,[2,3] a student-centered learning process like PBL should be helpful to our students in restoring confidence and building motivation to improve scores on the MCAT. Furthermore, in our experience, PBL has appeared to be an especially appealing learning strategy among minority students. Thus, it seemed natural to pose the question as to whether or not PBL methodology could be used to enhance the student performance in our MCAT Preparation Program.

Nationally standardized multiple-choice examinations are significant milestones in the training of physicians. Scores on the MCAT are important qualifications for admission to medical school, passing scores on United States Medical Licensure Examination (USMLE) Steps 1 and 2 are required for graduation. The goal of the MCAT is to help admission committees predict which of their applicants will be successful in medical school. [1]

THEORETICAL FRAMEWORK

Passage-Based Learning

Following the lead of other successful programs serving URM and especially the insights of Fullilove and Treisman[4], our program has focused on cooperative learning strategies. Additionally we have the educational goal of encouraging students to become self-directed learners, confident in their abilities to analyze problems and find information. Since this is the same goal that is embodied in PBL strategies,[5] we chose to use PBL as an educational tool for the program. We developed an adaptation of PBL methodology, designated 'passage-based learning' because it is based on solving MCAT passages. PBL methodology has been successfully used at Albert Einstein College of Medicine to help medical students prepare to retake the United State. Medical Licensing Examination (USMLE) Step 1.[6]

There are several reasons for believing that application of PBL techniques will enhance the learning experience and performance of our students during the MCAT Preparation Program. Standardized examinations increasingly emphasize integration of knowledge and problem-solving skills. The small-group format of PBL brings to bear the power of cooperative learning and encourages the development of collaborative problem-solving skills. Also, a major strength of the PBL process is its effect on students' motivation to learn. PBL stimulates student motivation, self-confidence, and reliance on self-directed learning strategies. [7]

METHODOLOGY

Participants

33 students participated in the MCAT Preparation Program since PBL was incorporated in 1999. Each participant has completed at least a bachelor's degree program and all premedical requirements, and has applied to IUSM. Characteristics of the 1999 and 2000 cohorts are shown on Table 1.

Table 1: Characteristics of the 1999 and 2000 cohorts

Cohort	Age	Residency		Gender		Ethnicity		
		In-state	Non-Resident	Female	Male	African American	Hispanic	White
1999	25	7	10	10	7	15	1	1
2000	24	7	9	7	9	16	0	0
Total		14	19	17	16	31	1	1

Orientation

We assumed that the students would not be familiar with PBL, which is not generally part of the premedical experience. To provide training in PBL in the context of our summer program, without compromising the effort devoted to MCAT preparation, we developed a PBL case for use during orientation. [8] The objectives of the case were, simultaneously, to introduce the students to PBL and to indicate the potential usefulness of PBL methodology in learning to solve MCAT-style problems.

Tutors

Four tutors helped the students achieve their goals of solving MCAT passages efficiently and explicitly. Tutors have completed the first year of medical studies, enjoy PBL, and achieved high scores on the MCAT. Tutors drew from their experience solving MCAT passages prior to becoming medical students, as well as their problem-based learning experience in a medical PBL course called Concepts of Health and Disease. Tutors met weekly to share experiences and discuss improvement strategies. Training was provided before tutors started their work.

Tutorial Sessions

Program participants met for 3 hours in small groups directed by a tutor, for 3 times weekly. The tutorial groups employ PBL methodology to facilitate student learning. PBL was 29% of the programmed instructional time of 31.5 hours per week.

Timed MCAT passages are used to stimulate participant learning as follows: (1) identify cognitive domains in which participant knowledge is weak or excellent; (2) restructure and reinforce information that is already learned; (3) develop reasoning proficiency when answering passage questions.

The following approach was used to solve a typical MCAT passage during PBL:

Individual passage solving (approximately 12 minutes) as follows: (1) Student previews the passage questions. (3) Student scans passage underlining key words, concepts, formulas, etc. (3) Student answers passage questions

Group discussions of passage (approximately 18 minutes) as follows: (1) Tutor designates a student or volunteer to read the passage. (2) Tutor designates different students or volunteers to answer each question providing a rationale for each answer. (3) Tutor and students use problem-based learning principles to promote active learning processes - students identify facts, identify and discuss learning issues and test-taking strategies, use the board to explain concepts, and etc. (4) Tutor and students use Bloom's Taxonomy [9] to promote a better understanding of how to process passage information and answer questions.

RESULTS

Over two summers, 33 (17 female, 16 male) students participated in the program. The average age of the program participants was approximately 25 years. For the purpose of analysis, students' most recent MCAT scores before matriculating in the program were used as pre-scores. MCAT scores reported after completing the program were used as post-scores.

Table 2 shows that mean MCAT composite score increased by 2.6 points (14%). The mean MCAT component scores increased as follows: Verbal Reasoning by 0.4 point (5%); Physical Sciences by 1.2 point (20%); and Biological Sciences by 1.1 point (17%).

Table 2: Change in mean MCAT sub and composite scores

Cohort	Verbal Reasoning	Physical Sciences	Biological Sciences	Sum
	Pre-post change	Pre-post change	Pre-post change	Pre-post change
1999	0.2 (3%)	0.6 (10%)	0.7 (9%)	1.5 (8%)
2000	0.5 (7%)	1.7 (29%)	1.5 (24%)	3.6 (20%)
Mean	0.4 (5%)	1.2 (20%)	1.1 (17%)	2.6 (14%)

Table 3 shows that 19 (58%, n=33) of the 1999 and 2000 participants increased their MCAT composite score by at least 3 points. While 14 (42%) participants achieved an increase of 4 points, 10 (30%) participants increased their composite score by 5 points. Four (12%) students increased their composite scores by 6 points.

Table 3 Number of participants with increases in MCAT composite scores.

Cohort	Class Size	Increase in MCAT composite score by at least			
		3 points	4 points	5 points	6 points
1999	17	8 (47%)	4 (29%)	1 (6%)	0 (0%)
2000	16	11 (69%)	10 (63%)	9 (56%)	4 (25 %)
Total	33	19 (58%)	14 (42%)	10 (30%)	4 (12%)

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A 6-item questionnaire, Table 4, was administered to assess student perceptions of the MCAT PBL experience. While 26 (79%) participants believed they learned a lot from the PBL sessions, 27 (82%) found the tutors to be helpful. Another 22 (67%) thought that PBL sessions were organized. Twenty-four (73%) participants observed that the PBL sessions promoted learning of concepts used in the test. While 25 (76%) participants thought that PBL sessions were helpful to prepare for the MCAT, 29 (88%) observed that the number of passages used during the PBL experience was adequate.

Table 4: Participant perceptions

	1999* n=17	**2000* n=16**	**Mean n=33**
I learned a lot during PBL sessions	11 (65%)	15 (94%)	26 (79%)
Tutors were helpful during the PBL sessions	13 (77%)	14 (89%)	27 (82%)
PBL sessions were organized	8 (47%)	14 (89%)	22 (67%)
PBL sessions promoted my learning of MCAT concepts	9 (53%)	15 (94%)	24 (73%)
PBL sessions helped me to prepare for the MCAT	10 (59%)	15 (94%)	25 (76%)
The number of passages used during PBL sessions was adequate	13 (77%)	16 (100%)	29 (88%)

* Percent statements equal to or greater than AGREE on the Response Scale
Questionnaire Response Scale:
1=Strongly Disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly Agree

DISCUSSION

Thirty-three students participated in the MCAT problem-based learning and academic performance improved during the summer of 1999 and 2000. Evaluation data from the summer of 1999 was used to improve the 2000 program.

Premedical students have to learn how to process and assimilate MCAT information in verbal reasoning, physical sciences and biological sciences. Information must be organized and retained in a manner that can be retrieved and used on the MCAT. Students learn how to apply, analyze, and evaluate knowledge needed to enhance performance on the test. These cognitive skills are most effectively developed by working through MCAT-type passages in a small group setting that promotes collaborative learning of all participants.

PBL was incorporated in the MCAT preparation experience to promote a more collegial relationship between program tutors and students, emphasize problem solving, and focus on group learning skills. This active learning methodology provides a context in which participants are challenged to refine their knowledge, thinking skills, attitudes, and behaviors essential for success in the MCAT.

Although incorporating PBL during the summer of 1999 and 2000 to prepare for the MCAT enhanced the academic performance of participants, reliable and valid measures of group dynamics and self-esteem of participants is needed. A comparative analysis of participants' learning and reasoning skills is also needed. Sustained improvements in cognitive outcomes are needed to determine the effectiveness of incorporating PBL in the MCAT preparation experience.

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